export, growth was rapid and profitable, but more recently has been affected adversely by reevaluation of currencies, industrial troubles, and developing competition for markets from Brazil, South Africa, and India.

The future will have to contend with the problems mentioned, also with the threat of a fuel crisis affecting shipping and, in the long term, the high phosphorus content of some of the ore. With huge reserves available, the demand for this iron ore will continue and some of the present problems will be solved.

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DEVELOPING BASALTIC ISLAND WATER SUPPLY—DIKE COMPLEX AND BASAL LENS

Rainfall, the primary source of water resources of basaltic islands such as Hawaii, is distributed contrastingly between low and elevated areas. Typically, in mountain areas rainfall averages 200 to 300 in. a year, whereas in coastal areas rainfall averages only 20 to 30 in. a year. In spite of the prolific rainfall in mountain areas, direct runoff in some watersheds amounts to as little as 20% of rainfall. A permeable basaltic rock terrane accounts for the great absorption of rainfall and the consequent creation of large bodies of groundwater in basaltic rocks. High-level groundwater bodies, present at elevations of as much as 1,000 ft in volcanic-dike complexes of wet mountain areas, are called dike water. Unseen below the surface, groundwater presumably moves from these high-level bodies into even greater and more extensive bodies of groundwater standing basally a few feet to several tens of feet above sea level as buoyant bodies of fresh water on salt water. Salt water saturates the island at depth. The problems of developing dike-complex water supplies relate primarily to hydrologic yield and utilization of natural storage, but the problems of developing basal-lens supplies involve the added constraint of the quality of water produced under pumping conditions. Infiltration tunnels, Maui-type shafts, and drilled wells are utilized in developing dike-complex and basal-lens water supplies. The method of development chosen depends upon the hydrology of the area, water supply design requirements, and economics.

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IRON ORES, COAL, AND STEEL PRODUCTION IN NEW ZEALAND

The present status of knowledge of iron ore and coal deposits in New Zealand is discussed with emphasis on titaniferous iron-sand ore and subbituminous coal. Development of steel production, first from scrap steel and subsequently from titaniferous iron sand, is described in relation to local logistic factors, market requirements, and development of production technology to suit local raw material characteristics. Possible future trends in production, marketing, and technology, and possible applications of the technology in other Pacific countries are mentioned briefly.

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KAPUNI AND MAUI GAS-CONDENSATE FIELDS OF NEW ZEALAND

The onshore Kapuni and offshore Maui gas-condensate fields containing New Zealand's only hydrocarbon reserves are in the Taranaki basin in the west of the North Island. Kapuni, discovered in 1959, first produced in May 1970. Maui, discovered in 1969 in 360 ft of water 25 mi offshore, is not due to produce until October 1978. Production from both fields is from Eocene sandstone reservoirs within the Kapuni Formation which was deposited between Late Cretaceous and Early Oligocene time in a widespread coastal plain and fluviomarine environment.

The original recoverable reserves of the 4-well Kapuni field, which produces from below 11,300 ft, are estimated at 460 million million BTU of dry gas (630 Bcf at 730 BTU/cu ft) and 34 million bbl of condensate. Production averaged 46.3 MMCFGD (carbon dioxide content 43%) and 3,500 b/d of condensate in 1973. With the additional wells to be drilled in 1974, the maximum deliverability reserves will increase to 260 MMCFGD and 18,000 b/d of condensate so that 108.7 million million BTU (about 24% of the original reserves and two thirds of the production) can be supplied as raw gas, with its original carbon dioxide content, to the New Plymouth power station during 1975-1978.

The reserves of the Maui field are estimated at 5,730 million million BTU of dry gas (5,590 Bcf at 1,025 BTU/cu ft) with 161 million bbl of condensate and 41 million bbl of recoverable LPG. Two platforms will be constructed 23 and 33 mi offshore. Processing facilities will handle a throughput of 750 MMCFGD and 20,000 b/d of condensate. The gas will fuel over 3,000 megawatts of generating capacity in North Island power stations.

Kapuni raw gas, without condensate, is sold at the field by Shell, BP, and Todd for NZ 17.5 cents/million BTU. The Natural Gas Corp. will remove carbon dioxide and distribute in the North Island. Maui gas will be sold at NZ 37 cents/million BTU delivered at the power stations. Development of the Maui field and associated processing and distribution facilities will be undertaken jointly by the New Zealand Government (50%) and Shell, BP, and Todd.

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PETROLIFEROUS TAIWAN BASIN IN TECTONIC FRAMEWORK OF WESTERN PACIFIC OCEAN

In the western Pacific, the Ryukyu fold belt extends southward, parallel with the Taiwan Sinzi fold zone, across the downwarped Okinawa trough, and, at the north end of Taiwan, they merge into the Taiwan Central Range complex. From the Miocene to the late Pleistocene, orogeny in Taiwan was increasingly more intense, pushing westward and northward to fold and thrust the sediments in the Neogene basin toward the west. However, the tectonic influence was limited only to the onshore sediments of the island.

Within the Taiwan Sinzi fold zone along the edge of the continental shelf of the East China Sea, the Taiwan basin covers the Taiwan Strait, the western coastal

plain, and the foothills as far as the Penghu-Peikang swell, North and west of the island, offshore seismic profiles show an acoustic basement above which are the predeformation and the postdeformation sedimentary layers separated by a widespread unconformity. The unconformity above the acoustic basement developed after the Mesozoic but before the Miocene, whereas the unconformity between the pre- and postdeformation layers developed after the Miocene. Therefore, we conclude that the predeformation layer was folded under the influence of the Miocene tectonic movement on the margin of the China mainland, which had ceased by the Pliocene-Pleistocene so that the young sediments are flat-lying above the unconformity.

Although the sediments of western Taiwan and offshore on the north and west were deposited in the same sedimentary basin, the tectonic movements on land were from a different source from those offshore. The orogeny on land was strong and late with its influence limited to the development of the structures in western Taiwan. The youngest structures may be sites for the accumulation of oil. The offshore part of the basin was not influenced by this late tectonic movement so that the sedimentary environment and the structure resulting from the Miocene tectonic movement on the margin of the continent should be considered as a possibility on the generation and accumulation of hydrocarbons.

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POTENTIAL FOR GEOTHERMAL ENERGY DEVELOPMENT IN ALASKA

The existence of significant geothermal resources in Alaska is suggested by approximately 100 thermal springs and more than 80 volcanoes, most of which have been active within the past million years. The potential for development of geothermal energy appears to be greatest along the Aleutian volcanic arc and in the large andesitic volcanic pile in the western Wrangell Mountains of east-central Alaska. Many of the volcanic centers in these two regions are similar to geothermal areas elsewhere in the world now being either actively prospected or developed. The Aleutian arc, for example, is near the contact between the North American and Pacific plates and contains more than 40 historically active volcanoes, at least 20 calderas, and 34 reported thermal springs, including some with subsurface temperatures estimated by chemical geothermometers as being above 200°C. The Wrangell volcanic pile contains many large stratovolcanoes, one of which, Mount Wrangell, still displays fumarolic activity near its summit. Others, such as nearby Mount Drum and Mount Sanford, are young volcanic centers whose size and silicic composition make them attractive as geothermal exploration targets.

Thermal springs in interior and southeastern Alaska are along fractured margins of granitic plutons and appear to represent deeply circulating meteoric water. Chemical geothermometers and the geologic setting suggest subsurface temperatures less than 180°C and reservoirs characterized by relatively low-recharge rates. Because of the demand for energy in remote regions, these relatively small geothermal areas may be among the first to be utilized in Alaska. Much of the potential use of geothermal energy in Alaska is for space and process heating rather than for producing electricity, but requirements and costs of electricity are changing rapidly.

The Wrangell volcanic pile is adjacent to major transportation routes and an intra-Alaska use would be likely for energy produced from a geothermal source in this region. The economic value of the potentially large geothermal areas in the Aleutian Islands and Alaska Peninsula, however, probably lies more in supplying the needs of industries with high-energy requirements.

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STATUS OF COAL EXPLORATION AND MINE DEVELOPMENT IN AUSTRALIA

The last decade has seen a spectacular increase in the growth of the Australian coal industry as a result primarily of the development of new mines in the Bowen basin of central Queensland. Queensland coal production has risen from less than 3 million tons in 1964 to over 18 million tons in 1973. Projected output in 1978 will be in excess of 34 million tons. This growth has followed the discovery of deposits of premium-grade metallurgical coal ideally suited for Japanese coke oven blends. These coals also have found recent acceptance in European steel mills, and 25% of the output of the largest producer, Utah Development Co., is now committed to this market. Also contributing to the industry's rapid growth is the amenability of the deposits to extraction by open-cut methods, and the proximity of the coalfields to good harbors in relatively unpopulated areas. The recent downturn in exploration has been the result of government policy to rationalize the utilization of the nation's coal resources, and to allow time for a reassessment of gross reserves. Previous estimates now have been upgraded dramatically. Gross reserves of New South Wales coal are assessed at over 100,000 million tons; 16,000 million tons of this are classified as first category. Queensland's gross reserves of first-category reserves have been assessed at nearly 9,000 million tons. Government and private company exploration now is being directed to less well-known coal basins and is expected further to increase the country's known reserves. Exploration programs now planned include a number to prove coal deposits for possible hydrocarbon generation in the Queensland Galilee basin and others to locate noncoking coal in southwestern and northwestern Western Australia. Work also is proceeding in delineating a large deposit of low-grade steam coal newly discovered in South Australia.

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HYDROGEOLOGY: PACIFIC SUMMARY

Plate tectonics has become a unifying concept in the earth sciences, and within its framework rational explanations of heretofore diverse and apparently singular geologic phenomena have followed. In the Pacific, hydrogeologic provinces fit naturally within the plate-tectonics framework.

Hydrogeologic provinces in the Pacific basin are classified as: (1) continental coasts and islands at the margins of continental plates; (2) arc islands associated with the margins of ocean plates; and (3) ocean islands thought to have formed as the result of hot spots